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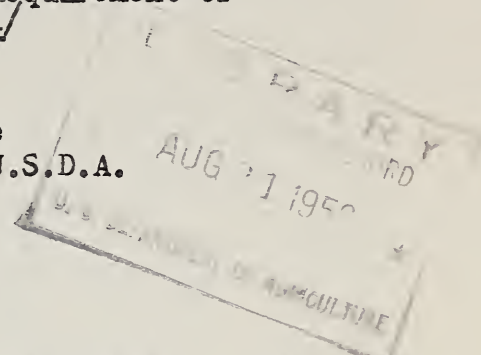
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A Preliminary Report on the Maintenance Requirement of
Dairy Cows and its Variation[1]

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The data in the literature on the maintenance requirement of the dairy cow is limited. Some of the available data can only be considered as being of a survey type. It mainly consists of data on three cows studied by Haecker (1) eight cows by Eckles (2) and 20 cows by Hills (3). Most of the body weight data in the Hills experiment were lost and none of the original data are presented in usable form. The digestibility of the feeds used was not measured by Haecker or Hills and some of the animals used by all three investigators were low producers and/or "beefy" in type. A reappraisal of the maintenance requirement with additional information on the variation among cows and the repeatability and errors involved in its measurement appeared desirable.

This was done by feeding U.S. #1 alfalfa hay to mature dry open dairy cows in amounts that would maintain their body weight. This amount of alfalfa was taken as the maintenance requirement. Differences in the maintenance requirement were used to estimate the variability at different times and the repeatability of the measurement.

The cows were stall-fed throughout the year and were allowed to run in a dry lot for exercise several hours each day. Steamed bone meal, trace mineralized salt and water were supplied ad libitum. The cows were weighed on two consecutive days every five days. Holstein and Jersey cows from eight different herds were used including three sets of identical twins. The data obtained during the first 30 to 60 days of alfalfa feeding were considered as preliminary and were not used in the final summary of data. The cows were kept on one particular feed for a period well over 100 days in length wherever possible. Aliquots of hay fed were obtained every day and composited by 10 day periods for dry matter and other analysis.

The original data are presented in Table 1. A weighted average for hay consumed was calculated for each trial. In the first trial several different alfalfa hays were used and an approximate analysis is given for

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this material. The first trial covered a period of 684 cow days and the average alfalfa hay dry matter (D. M.) consumed by the average 1113 lb. cow was 13.93 lb. with a body weight gain of 0.18 lb./day/cow. In the second trial extending over 1017 cow days the average D. M. consumed by the average 1185 lb. cow was 15.72 with a body weight gain of 0.27 lb./cow/day. In the three remaining trials the body weight changes were relatively small. In trial 3 covering 740 cow days the D. M. consumed by the average 1262 lb. cow was 14.96 with a gain of 0.07 lb./day/cow. In trial 4 covering 1231 cow days the average D. M. consumed by the average 1208 lb. cow was 13.88 with a loss of body weight of 0.09 lb./day/cow. During trial 5 the same lot of alfalfa was fed as in trial 4 but it had a somewhat different composition. Trial 5 covered 1290 cow days and the average D. M. consumed by the average 1251 lb. cow was 14.77 with a body weight gain of 0.05 lb./day/cow.

An approximation of the average maintenance requirement for a 1,000 lb. cow could be calculated by assuming a direct proportion between maintenance and body weight and assuming a correction for the small weight changes. When the weight changes were assigned their usually accepted value (4) the average maintenance requirement ranged from 11.4 to 11.9 lb. of alfalfa dry matter per 1,000 lb. body weight. When the weight change was assigned the value estimated from these experiments the average maintenance requirement ranged from 11.6 to 12.3 lb. D. M./1,000 lb. Assuming that the total digestible nutrient content of the alfalfa dry matter was 59% the extreme range in average maintenance requirement for a 1,000 lb. cow would be 6.7 to 7.2 lb. total digestible nutrients.

In order to compare the requirement of different cows and the same cow at different times, some method of standardizing the data to a given body weight and correcting for the small body weight changes must be made. One type of formula that has been used to express the relationship of intake (I) to body weight (W) and weight change (G) is $I = k_1W^bk_2G$, in which k_1 and k_2 are constants and b is a power of body weight. By assuming that $k_1 = 0.001$ and b and $k_2 = 1.0$ we obtain $\frac{I}{W} = G$ or intake per 1,000 lb. is equal to G. When intake per 1,000 lb. was correlated with gain in body weight per day a correlation coefficient of 0.64 (P > 0.01) was obtained for the 52 observations calculated from the data in Table 1. The regression equation was $\hat{Y} = 12.01 + 3.45X$ in which Y = estimated D. M. intake per 1,000 lb. body weight and X = body weight change in lb./day and the standard error of b was 0.58 (P > 0.01).

This method was used to estimate the maintenance requirement of ten cows that were fed three different lots of alfalfa hay during trials 3, 4 and 5. The results of these calculations are presented in Table 2. The lower value would indicate greater efficiency in utilization of feed for maintenance. The ten cows were placed in three groups. The first four cows in Table 2 were the most efficient and the last three cows were the least efficient. In general the cows remained in the specific group during each trial.

The average requirement during these three trials was approximately the same for each trial. The range in standard deviation of each average was from 0.4 to 0.8 and the coefficient of variation was about 5%. The high value for these two statistics during trial 5 was due to the high value for cow 197. This cow became very nervous during this trial and the amount of hay necessary to maintain body weight increased. The coefficient of variation during this last trial when the data of this cow was omitted was 4.3%. The coefficient of variation during trials 1 and 2 was also under 5%. An analysis of variance was performed on the data in Table 2 which showed that there was difference between cows ($P < .05 > .01$). The repeatability was .41 and the standard deviation within cows was ±0.5.

Although the alfalfa dry matter necessary to maintain any one cow at different times was not as reproducable as could be desired, the variation among the cows remained about the same when different hays were fed. The fact that repeatability (.41) and the consistency of coefficient of variation (5%) are reasonable would indicate a good degree of precision in the measurement.

The calculations made for the data presented in Table 2 represent only one method of calculating the data presented in Table 1. It was used here to standardize the data obtained on cows of varying body weights and gains in order to obtain an indication of the variation within the group at different times. Other more complex formula relating intake to body weight and gain may be more applicable to the original data and that is now being investigated.

From the data obtained by feeding alfalfa hay to mature dry open dairy cows in amounts necessary to maintain body weight it can be concluded that about 12 lb. of U.S. #1 alfalfa hay dry matter per day will maintain the body weight of a 1,000 lb. cow. The coefficient of variation found in this value was about 5% and the standard deviation was about ± .5. A difference between cows in their maintenance requirement was shown which reflects a difference in the efficiency of these cows in their utilization of feed for maintenance.

(1) T. L. Haecker, Minnesota Agri. Exp. Sta., Bul. 79, 1903.
(2) C. H. Eckles, Missouri Agri. Exp. Sta., Bul. 4, 1911 and Bul. 7, 1913.
(3) J. L. Hills, Vermont Agri. Exp. Sta., Bul. 226, 1922.
(4) J. C. Knott, R. E. Hodgson and E. V. Ellington, Washington, Agri. Exp. Sta., Bul. 295, 1934.

Table 1.-Original data on all cows of maintenance experiment showing average body weight, change in weight, dry matter consumed and its composition during the 5 trials

Cow No.	Breed	Trial 1 — Misc. Alfalfa Hays Period Length (days)	Body weight Average (lb.)	Body weight Change (lb/day)	Dry Matter Consumed (lb/day)	Trial 2 — Alfalfa Hay No. 263 Period Length (days)	Body weight Average (lb.)	Body weight Change (lb/day)	Dry Matter Consumed (lb/day)	Trial 3 — Alfalfa Hay No. 264 Period Length (days)	Body weight Average (lb.)	Body weight Change (lb/day)	Dry Matter Consumed (lb/day)	Trial 4 — Alfalfa Hay No. 267-1 Period Length (days)	Body weight Average (lbs.)	Body weight Change (lb/day)	Dry Matter Consumed (lb/day)	Trial 5 — Alfalfa Hay No. 267-2 Period Length (days)	Body weight Average (lbs.)	Body weight Change (lb/day)	Dry Matter Consumed (lb/day)
183	H					110	1414	+.30	17.42	80	1438	-.23	14.82	110	1397	-.38	14.52	110	1395	+.29	16.55
187	H	50	1198	0	15.71	119	1201	+.05	15.32	80	1211	-.05	14.52	110	1215	+.14	13.53	110	1222	0	12.53
188	H									30	1198	+.17	14.40	110	1206	-.04	13.84	110	1212	+.11	13.52
191	H					50	1365	+.04	17.30	80	1369	+.21	16.68	110	1373	-.17	15.70	110	1359	+.05	15.49
192	H					50	1357	+.06	18.17	70	1394	+.11	17.59	110	1391	+.02	16.11	110	1388	+.05	15.28
196	H					119	1098	+.39	15.90	80	1151	+.35	14.36	110	1143	0	13.47	110	1153	+.10	13.08
197	H					110	1135	+.55	15.87	80	1161	+.16	14.60	110	1150	-.14	14.30	110	1142	+.23	14.11
291	H					80	1303	0	16.89	80	1314	-.01	14.39	110	1301	-.07	14.04	110	1302	-.02	14.22
293	H					119	1308	+.16	17.32	80	1322	0	15.56	110	1313	-.21	14.97	110	1297	-.01	15.11
2696	J	130	1040	+.12	12.40	110	1037	+.05	12.80	80	1060	+.08	12.65	110	1046	-.19	12.34	110	1062	+.08	13.81
2643	J	70	1246	+.85	17.88													80	1025	-.02	15.28
194	H	160	1546	+.03	16.96																
199	H	67	774	-.06	11.07																
687	J	67	1045	+.02	14.55																
828	H	91	885	+.24	9.154																
1008	J	50	921	+.46	11.954																
653	J																				
681	J					50	834	+.76	13.53												
645	J													131	830	+.03	10.544[2]				
2408	H																	110	1388	+.19	18.65
635	H					100	990	+.65	13.48[3]												
817 [1]	H	140	1386	+.54	12.57[3]	130	1408	+.01	11.50[3]	80	1389	-.39	11.44[2]	110	1383	+.14	11.75[2]	110	1365	-.30	11.47[2]
Total weighted		684				1117				740				1231				1290			
Average daily ave.			1113	+.18	13.93		1185	+.27	15.72		1262	+.07	14.96		1208	-.09	13.88		1251	+.05	14.77
Average for 1000 lb. cow				+.18	12.51			+.27	13.27			+.07	11.85			-.09	11.49			+.05	11.81
					11.41[2]				11.63[2]				11.42[2]				11.92[2]				11.50[2]
					11.88[3]				12.32[3]				11.60[3]				11.81[3]				11.63[3]

Composition of the Alfalfa Dry Matter Fed

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Protein (%)	17.5	18.32	20.58	15.83	17.63
Fiber (%)	31.7	29.55	26.88	31.15	28.44
N.F.E. (%)	42.1	42.67	42.41	43.78	44.65
E.E. (%)	1.5	1.49	1.62	1.95	2.01
Ash	7.2	7.97	8.50	7.30	7.27

1/ This cow received 30% of total dry matter as grain.
2/ Corrected to zero body weight change assuming alfalfa dry matter = 58% T.D.N. and 3.53 lb. TDN/lb. gain and 2.73 lb. TDN/lb. loss in body weight.
3/ Corrected to zero body weight change assuming alfalfa dry matter = 3.51 lb. D. M. per lb. change in body weight.
4/ These cows were pregnant.

Table 2.-Amount of alfalfa dry matter required for maintenance[1] by 10 cows on three different trials

Cow No.	Trial 3	Trial 4	Trial 5
291	11.0	11.0	11.0
188	11.4	11.6	10.8
183	11.1	11.7	10.9
187	12.2	10.7	10.3
191	11.5	12.0	11.2
196	11.5	11.8	11.0
192	12.2	11.5	11.2
293	11.8	12.1	11.7
2696	11.7	12.5	11.9
197	12.0	12.9	13.4
Alfalfa lot no.	264	267-1	267-2
Average	11.7	11.8	11.3
St. Deviation	± .4	± .7	± .8 (5)
Coef. Variation (%)	3.6	5.5	7.5 (4.3)

F between cows = 3.12*
Standard deviation of average value for cows = .92
Standard deviation within cows = .52

[1] Expressed as dry matter required per 1,000 lb. body weight by direct proportion and corrected for body weight changes according to the derived factor of 3.45 lb. dry matter per lb. weight change.